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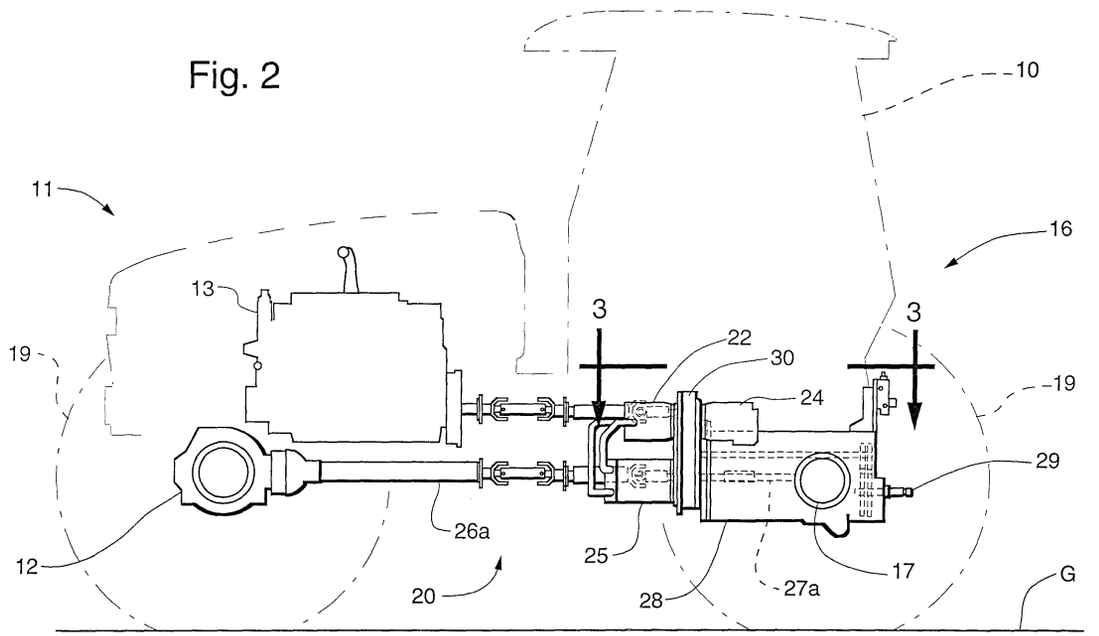
(54) Integrated splitter gearbox for four wheel drive tractors

(57) A splitter gearbox (30) for a four wheel drive, hydrostatically driven tractor integrates both the input drive train and the output drive train into a single gearbox. The splitter gearbox (30) is mounted to the rear axle housing (17) to allow the sharing of a common oil sump. The front and rear axles (12, 17) of the tractor are driven from a single hydrostatic motor (25) associated with a gear drive system that provides a shaft (38) extending forwardly and rearwardly out of the splitter gearbox (30) to drive, respectively, the front and rear axles (12, 17) of the tractor. An auxiliary pump drive (40) is mounted to the side of the splitter gearbox (30) and is driven from an idler gear (43) appropriately positioned within the auxiliary pump drive housing (44).

Fig. 2



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Description

[0001] This invention relates generally to four wheel drive articulated tractors and, more particularly, to improvements to the drive system for hydrostatically driven tractors.

[0002] It is desirable to integrate all the drives for the input driven components of an articulated four wheel drive tractor into a single gearbox affixed to the rear axle housing of the tractor. Such a mechanism would place the hydrostatic pump for powering the traction drive of the tractor, the hydraulic pump for the tractor hydraulic system, the drive for the power-takeoff (PTO) system, and any auxiliary hydraulic pumps to be driven off the same gearbox device with the output driver components, including the hydrostatic motor, speed reduction gears and output drive shafts.

[0003] Lubrication of a gear set is a consideration in the design of a gearbox device for transferring rotational power through gear sets arranged and configured to provide the proper rotational speed to a component driven from the engine of the tractor. Communizing lubrication sumps can minimize the number of lubrication systems that need to be provided as well as provide more effective lubrication of the gear sets and the cooling of the lubrication fluid.

[0004] Conventional tractor drive mechanisms include a mechanical transmission to provide different output speeds for a given engine input speed. Even hydraulically driven tractors have utilized a three speed mechanical transmission between the engine and the hydrostatic pump to provide desired different input speeds to the operation of the hydrostatic pump for powering the movement of the tractor. It would be desirable to replace the three speed mechanical transmission on hydrostatically driven tractors to minimize cost and to enhance operation of the tractor.

[0005] The gearbox would preferably be configured to mount the auxiliary pump drive mechanism in an optional manner so that the auxiliary pump could be added to the gearbox, if desired, and be driven therefrom.

[0006] It is therefore an object of this invention to integrate the drive mechanisms for a hydrostatically driven, four wheel drive tractor in which all the drives are driven from a single splitter gearbox.

[0007] According to a first aspect of the present invention, a vehicle is provided having a chassis supported by a front axle assembly and a rear axle assembly, an engine for providing operative power, and a drive mechanism.

[0008] The vehicle is characterized in that the drive mechanism comprises a splitter gearbox mounted to the rear axle assembly to share a common oil sump therewith, said splitter gearbox being operatively connected to said engine to receive rotational power therefrom and being operatively connected to said front and rear axle assemblies to deliver rotational power thereto.

[0009] According to a further aspect of the present invention, a vehicle is provided having a chassis supported by a front axle assembly and a rear axle assembly, and an engine for providing operative power for said vehicle.

[0010] The vehicle is characterized in that it further comprises :

- a hydrostatic pump supported on said chassis and arranged to receive rotational power from said engine through a mechanical apparatus including a power input shaft;
- a variable displacement hydrostatic motor supported on said chassis to be in flow communication with said hydrostatic pump for hydraulically receiving operative power therefrom and for generating rotational power; and
- an output shaft mechanically connected to said hydrostatic motor to transfer rotational power generated by said hydrostatic motor to both said front axle assembly and said rear axle assembly to effect a driving connection therewith for the purpose of delivering traction power thereto.

[0011] According to a still further aspect of the present invention, a vehicle is provided having a chassis supported by a front axle assembly and a rear axle assembly, an engine for providing operative power for said vehicle, and a drive mechanism.

[0012] The vehicle is characterized in that the drive mechanism comprises a splitter gearbox including :

- a housing having a removable cover plate; and
- an auxiliary hydraulic pump assembly being selectively mountable on said housing as a replacement for said removable cover plate.

[0013] It is an advantage of the present invention that the mounting of the splitter gearbox to the rear axle housing reduces complexity. As the front and rear axles of the four wheel drive tractor are driven from a variable displacement hydrostatic motor, the tractor need not have a conventional transmission in order to obtain customary speed ranges desired for a tractor. The hydrostatic motor is provided with a selected number of preset swash plate positions to effectively replace a conventional transmission gearbox. The fixed positions of the variable displacement hydrostatic motor, coupled with a variable speed hydraulic pump, can be controlled electronically to provide a smooth power-shifting operation. As such, the tractor does not require stopping to shift gears in order to change the range of operation of the tractor.

[0014] The splitter gearbox incorporates a gear drive system in association with the hydrostatic motor to provide a shaft extending forwardly and rearwardly out of the splitter gearbox to drive, respectively, the front and rear axles of the tractor, which are thus driven from a single hydrostatic motor. Moreover, the input drive train

and the output drive train are incorporated into a single splitter gearbox.

[0015] An auxiliary pump drive can be mounted as an option to the side of the splitter gearbox. The auxiliary pump can be driven from an idler gear appropriately positioned within the splitter gearbox.

[0016] The present invention aims to provide a splitter gearbox for a four wheel drive, hydrostatically driven tractor which is durable in construction, inexpensive of manufacture, carefree of maintenance, facile in assemblage, and simple and effective in use.

[0017] The present invention will now be described further, by way of example, with reference to the accompanying drawings, in which :

Figure 1 is a side elevational view of a four wheel drive, articulated tractor incorporating the principles of the instant invention, portions of the tractor being broken away for purposes of clarity;

Figure 2 is a schematic side elevational view of the drive mechanism having a splitter gearbox and associated drives incorporating the principles of the instant invention;

Figure 3 is a top plan view of the splitter gearbox and rear axle housing corresponding to lines 3--3 of Figure 2;

Figure 4 is a front elevational view of the splitter gearbox and associated drives corresponding to lines 4--4 of Figure 3;

Figure 5 is a rear elevational view of the splitter gearbox corresponding to lines 5--5 of Figure 3;

Figure 6 is a cross-sectional view through the splitter gearbox taken along lines 6--6 of Figure 3;

Figure 7 is a cross-sectional view of the splitter gearbox taken along lines 7--7 of Figure 6 to depict the gear drive system for driving the front and rear axles from a single hydrostatic motor shown in phantom;

Figure 8 is a cross-sectional view of the splitter gearbox similar to that of Figure 6 to depict the addition of an optional auxiliary pump mechanism; and

Figure 9 is a top plan view of the splitter gearbox and rear axle housing similar to that of Figure 3 but with an optional auxiliary hydraulic pump mounted to the splitter gearbox.

[0018] Referring now to Figure 1, a four wheel drive, articulated tractor incorporating the principles of the instant invention can best be seen. The articulated tractor 10 includes a forward engine end 11 supported above the ground G by a front axle assembly 12 and carrying an engine 13. The rearward cab end 16 of the tractor 10 is supported above the ground by a rear axle assembly 17 and has an operator's station 18 mounted thereon. Each of the front and rear axle assemblies 12, 17 is provided with a pair of opposing wheels 19 for mobile movement of the tractor 10 over the surface of the ground G. The front and rear ends 11, 16 of the tractor 10 are connected by an articulation joint 15, the manipulation of which effects steering of the tractor 10 in a known manner.

[0019] As best seen in Figures 1 - 7, the tractor 10 is provided with a drive system 20 that is operatively connected to the engine 13 to provide operative power for the front and rear axle assemblies 12, 17. The drive system 20 includes a splitter gearbox 30 mounted on the front of the rear axle assembly 17 in a manner to share the oil sump therewith for lubrication purposes. The drive system 20 also includes the input drive components, including a hydrostatic pump 22 for powering the traction drive of the tractor 10, a hydraulic pump 24 for pressuring the hydraulic system of the tractor 10, and a power takeoff (PTO) mechanism 29; and the output drive components, including a variable displacement hydrostatic motor 25 to provide operative power to both the front and rear axle assemblies 12, 17 through front and rear output drive shafts 26, 27.

[0020] The splitter gearbox 30 receives rotational power from the engine 13 via a power input shaft 31 interconnecting the engine 13 and the splitter gearbox 30 to rotate the input gear 32. As best seen in Figures 4 - 6, the input gear 32 is drivingly engaged with a first idler drive gear 33, the size of the respective gears 32, 33 being selected to provide the appropriately desired gear reduction. The first idler drive gear 33 is drivingly engaged with a pump drive gear 34 having both the hydrostatic pump 22 and the hydraulic pump 24 coaxially mounted therewith, the hydrostatic pump 22 being mounted on the front of the splitter gearbox 30 and the hydraulic pump 24 being mounted on the rear of the splitter gearbox 30. The idler drive gear 33 is also drivingly engaged with the PTO drive gear 39 for powering the PTO mechanism 29 as a direct drive input from the engine 13.

[0021] As best seen in Figures 3 - 7, the hydrostatic pump 22 is operable to circulate hydraulic fluid under pressure to a variable displacement hydraulic motor 25 mounted on the front of the splitter gearbox 30 below the hydrostatic pump 22 to drive rotation of the hydraulic motor 25. The drive pinion 35 of the hydrostatic motor 25 is drivingly engaged with a second idler gear 36, which is also appropriately sized to provide the desired gear reduction. The second idler gear 36 is drivingly engaged with a traction drive gear 37 having a single shaft 38 extending therethrough to project both forwardly and rearwardly from the splitter gearbox 30 and from the front and rear output drive shafts 26, 27. Control of the hydrostatic pump is effected through a conventional mechanical linkage.

[0022] The hydrostatic motor 25 is preferably set-up with three pre-set, fixed swash plate angles to provide three positive displacements for the motor 25 to proximate a conventional operation of the tractor 10. By utilizing the variable displacement of the hydrostatic motor 25 and/or a variable speed hydrostatic pump 22, the infinite speed adjustment for the tractor 10 can still be at-

tained on-the-go. Using an electronic control system to control the operation of the motor 25, such as by modulating the displacement of the motor 25, and to control the operation of the pump 22, a very smoothly operating power-shift tractor 10 will result without requiring the operator to stop the tractor to change gears in a mechanical transmission, as is conventional. The fixed, pre-set displacements for the hydrostatic motor 25 provide maximum torque and minimum speed at a first position, a mid-range of both torque and speed at a second position, and a minimum torque with maximum speed for roading operations at a third position.

[0023] As best seen in Figures 1 and 2, the front axle assembly 12 is drivingly connected to the front output drive shaft 26 by a front drive shaft assembly 26a. The rear axle assembly 17 is drivingly connected to the rear output drive shaft 27 by a rear drive shaft assembly 27a passing internally through the housing 28 of the rear axle assembly 17. Likewise, the PTO mechanism 29 is drivingly connected to the PTO drive gear 39 and passes through the housing 28 of the rear axle assembly 17 and projects rearwardly therefrom for remote connection to an apparatus (not shown) for delivering rotational power thereto.

[0024] Accordingly, the top portion of the splitter gearbox 30 receives rotational power directly from the engine 13 and drives the input drive train components, including the hydrostatic pump 22, the hydraulic pump 24 and the PTO mechanism 29. The lower portion of the splitter gearbox 30 receives operative power from the hydrostatic motor 25 operatively driven from the hydrostatic pump 22 and delivers the rotational power through the output shafts 26, 27 to drive the front and rear axle assemblies 12, 17 from a single hydrostatic motor 25 off of a single gear drive set 35-37.

[0025] Referring now to Figures 8 and 9, the configuration is shown of the splitter gearbox 30 to receive an optional, auxiliary hydraulic assembly 40, which includes an auxiliary pump 41, having a drive pinion 42, and a rotatably mounted third idler gear 43 drivingly engaged with the drive pinion 42. The third idler gear 43 projects outwardly from the housing 44 of the auxiliary hydraulic assembly 40 such that the mounting of the housing 44 to the side of the splitter gearbox 30, as described in greater detail below, will cause the third idler gear 43 to become drivingly engaged with the input gear 32 and, thereby, drive the operation of the auxiliary pump 41, which can then supplement the operation of the primary hydraulic pump 24.

[0026] The process for installing the auxiliary hydraulic assembly 40 is best seen in Figure 8. First the removable side cover 45 of the splitter gearbox 30 is detached from the splitter gearbox 30. The auxiliary hydraulic assembly 40 is then positioned such that the third idler gear 43 extends into the opening in the side of the splitter gearbox 30 formed with the removal of the side cover 45 and becomes engaged with the input gear 32 to receive rotational power directly from the engine 13, as is the primary hydraulic pump 24. The housing 44 is then bolted into place on the side of the splitter gearbox and sealed thereto as a replacement for the side cover 45.

[0027] The splitter gearbox configuration described above provides a number of different operational configurations for the operator of this hydrostatically driven tractor 10. By disengaging all other output components, the operator can choose to direct the entire power of the engine 13 to the hydrostatic motor 25 to provide for maximum speed and/or pulling torque of the tractor 10 through one of the pre-set fixed positions of the motor 25. Alternatively, the operator could disengage the hydrostatic motor 25 by placing its swash plate in a neutral position and run the entire power of the engine 13 through the PTO shaft 29, while the tractor 10 remains stationary. Another alternative for the operator, would be to disengage both the hydrostatic motor 25 and the PTO mechanism 29, and run the entire power of the engine 13 through the auxiliary hydraulic system 40. Yet another alternative for the operator would be to disengage all of the hydrostatic motor 25, the PTO mechanism 29, and the auxiliary hydraulic system 40 (if the tractor 10 is so equipped), and divert as much of the power from the engine as possible through the tractor hydraulic system through the hydraulic pump 24; however, since both the hydrostatic pump 22 and the hydraulic pump 24 are run from the same gear 34, less than full engine power can be run through the tractor hydraulics. One skilled in the art will readily recognize that a combination of the above systems will typically be operated, and the operator will have appropriate choices to make for application of the power from the engine 13.

Claims

1. A vehicle having a chassis supported by a front axle assembly (12) and a rear axle assembly (17), an engine (13) for providing operative power, and a drive mechanism (20); and

   characterized in that the drive mechanism (20) comprises a splitter gearbox (30) mounted to the rear axle assembly (17) to share a common oil sump (-) therewith, said splitter gearbox (30) being operatively connected to said engine (13) to receive rotational power therefrom and being operatively connected to said front and rear axle assemblies (12, 17) to deliver rotational power thereto.

2. A vehicle according to claim 1, characterized in that said splitter gearbox (30) has supported therefrom and provides operative power to :

   - a hydrostatic pump (22) providing traction power for powering the front and rear axle assemblies (12, 17);
   - a hydraulic pump (24) providing hydraulic fluid under pressure to a hydraulic system (-) on said

vehicle; and

- a power takeoff mechanism (29).

3. A vehicle according to claim 2, characterized in that said splitter gearbox (30) further supports a hydrostatic motor (25) and output drives (26, 27) interconnecting said splitter gearbox (30) and said front and rear axle assemblies (12, 17) to provide traction power thereto, said hydrostatic motor (25) being operatively connected to said hydrostatic pump (22) to receive hydraulic fluid under pressure therefrom.

4. A vehicle according to claim 3, characterized in that said hydrostatic motor (25) is engaged with an output gear set (35-37) to transfer rotational power from said hydrostatic motor (25) to both said front and rear axle assemblies (12, 17).

5. A vehicle according to any of the claims 2 to 4, characterized in that the splitter gearbox (30) further comprises :

- a power input shaft (31) delivering rotational power to said splitter gearbox (30) from said engine (13); said hydrostatic pump (22) being operatively connected to said power input shaft (31) to receive rotational power therefrom; and
- an output shaft (38) mounted in said splitter gearbox (30) in mechanical communication with said front and rear axle assemblies (12, 17) to effect a driving connection therewith for the purpose of delivering traction power thereto.

6. A vehicle according to claim 5 when appended to claim 4 characterized in that said splitter gearbox (30) further includes an input gear set (32-34) associated with said hydrostatic pump (22) to transfer rotational power from said input shaft (31) to said hydrostatic pump (22); said input and output gear sets (32-34, 35-37) sharing a common lubrication sump (-).

7. A vehicle according to claim 6, characterized in that said input gear set (32-34) includes a PTO drive gear (39) for driving said PTO mechanism (29); said PTO mechanism comprising a shaft (29) that extends out of said splitter gearbox (30) for remote access thereto.

8. A vehicle according to claim 6 or 7, characterized in that said input gear set (32-34) also drives said hydraulic pump (24).

9. A vehicle according to claim 8, characterized in that said input gear set (32-34) includes a drive gear (34) connected to said hydrostatic pump (22) for effecting rotation thereof, said drive gear (34) also being connected to said hydraulic pump (24) for simultaneous operation of both said hydrostatic pump (22) and said hydraulic pump (24).

10. A vehicle according to any of the claims 5 to 9, characterized in that said output shaft (38) extends both fore and aft of said splitter gearbox (30) to be operatively coupled simultaneously in mechanical communication with both said front axle assembly (12) and said rear axle assembly (17) to effect a driving connection therewith for the purpose of delivering traction power thereto.

11. A vehicle according to any of the claims 5 to 10, when appended directly or indirectly to claim 4, characterized in that said output gear set (35-37) includes a driven gear (37) rotatably driven from said hydrostatic motor (25); said driven gear (37) being mounted on a central portion of said output shaft (38).

12. A vehicle having a chassis supported by a front axle assembly (12) and a rear axle assembly (17), and an engine (13) for providing operative power for said vehicle, and

characterized in that the vehicle further comprises :

- a hydrostatic pump (22) supported on said chassis and arranged to receive rotational power from said engine (13) through a mechanical apparatus including a power input shaft (31);
- a variable displacement hydrostatic motor (25) supported on said chassis to be in flow communication with said hydrostatic pump (22) for hydraulically receiving operative power therefrom and for generating rotational power; and
- an output shaft (38) mechanically connected to said hydrostatic motor (25) to transfer rotational power generated by said hydrostatic motor (25) to both said front axle assembly (12) and said rear axle assembly (17) to effect a driving connection therewith for the purpose of delivering traction power thereto.

13. A vehicle according to claim 12, characterized in that said hydrostatic motor (25) is configured with at least three pre-set fixed displacement settings.

14. A vehicle according to claim 13, characterized in that said pre-set fixed displacement settings are selected to provide different combinations of torque capability and output speed of the hydrostatic motor (25).

15. A vehicle according to claims 13 or 14, characterized in that said hydrostatic motor (25) is controlled electronically for shifting between said pre-set fixed displacement settings.

16. A vehicle according to any of the claims 12 to 15 characterized in that said hydrostatic pump (22) is operable at variable speeds to vary the operative power conveyed hydraulically to said hydrostatic motor (25), the operation of said hydrostatic pump (22) being controlled mechanically.

17. A vehicle according to any of the claims 12 to 16, characterized in that said hydrostatic pump (22) and said hydrostatic motor (25) are mounted on a splitter gearbox (30) supported on said chassis and wherein said hydrostatic pump (22) is mechanically associated with a first mechanical gear set (32-34) transferring rotational power from said power input shaft (31), said hydrostatic motor (25) being associated with a second mechanical gear set (35-37) for transferring power to said output shaft (38), both said first and second gear sets (32-34, 35-37) being housed within said splitter gearbox (30).

18. A vehicle according to claim 17, characterized in that said first gear set (32-34) includes a first drive gear (39) for a PTO mechanism (29) having a PTO shaft (29) that extends out of said splitter gearbox (30) for remote access thereto, said PTO mechanism (29) being selectively engageable independently of said hydrostatic motor (25) such that said vehicle can be operated with all of the rotational power from said engine (13) being utilized selectively by said PTO mechanism (29) for operation of a remote device or by said hydrostatic motor (25) for traction of said vehicle.

19. A vehicle according to claim 17 or 18, characterized in that said splitter gearbox (25) further includes an auxiliary hydraulic pump (24) selectively connectable to said first gear set (32-34) to provide hydraulic power to a remote mechanism, said PTO mechanism (29) and said hydrostatic pump (22) being selectively disengageable to permit substantially all of said rotational power from said engine (13) to be utilized through said auxiliary hydraulic pump (24).

20. A vehicle having a chassis supported by a front axle assembly (12) and a rear axle assembly (17), an engine (13) for providing operative power for said vehicle, and a drive mechanism (20); and

characterized in that the drive mechanism comprises a splitter gearbox (30) including :

- a housing (30) having a removable cover plate (45); and
- an auxiliary hydraulic pump assembly (40) being selectively mountable on said housing as a replacement for said removable cover plate (45).

21. A vehicle according to claim 20, characterized in that said splitter gearbox (30) further comprises :

- a power input shaft (31) delivering rotational power to said splitter gearbox (30) from said engine (13);
- a hydrostatic pump (22) mounted on said housing (30) and being operatively connected to said power input shaft (31) to receive rotational power therefrom for powering the front and rear axle assemblies (12, 17);
- a hydrostatic motor (25) mounted on said housing (30) in flow communication with said hydrostatic pump (22) to receive operative power therefrom; and
- an output shaft assembly (38) mounted in said splitter gearbox (30) in mechanical communication with said front and rear axle assemblies (12, 17) to effect a driving connection therewith for the purpose of delivering traction power thereto.

22. A vehicle according to claim 21, characterized in that said splitter gearbox (30) further includes :

- an input gear set (32-34) associated with said hydrostatic pump (22) to transfer rotational power from said input shaft (31) to said hydrostatic pump (22);
- an output gear set (35-37) associated with said hydrostatic motor (25) to transfer rotational power generated by said hydrostatic motor (25) to said output shaft (38), said input and output gear sets (32-34, 35-37) sharing a common lubrication sump; and
- said auxiliary hydraulic pump assembly (40) being operatively connected to said input gear set (32-34) to receive operative rotational power therefrom.

23. A vehicle according to any of the claims 20 to 22, characterized in that said auxiliary hydraulic pump assembly (40) includes:

- a housing (44) connectable to said splitter gearbox housing (30) as a replacement for said removable cover plate (45);
- an auxiliary hydraulic pump (41) supported in said housing (44) and having a drive pinion (42) affixed thereto; and
- an idler gear (43) rotatably mounted in said housing (44) for operative engagement with said drive pinion (42), said idler gear (43) projecting outwardly from said housing (44) for driving engagement with a gear (32) within said splitter gearbox (30) when said housing (44) is connected to said splitter gearbox (30), said idler gear (43) being rotatably driven by said gear (32) of said splitter gearbox (30) and trans-

ferring said rotational movement to said auxiliary hydraulic pump drive pinion (42) for powering the operation of said auxiliary hydraulic pump (41).

24. A vehicle according to claim 22 or 23, characterized in that said input gear set (32-34) includes a first drive gear (39) for a PTO mechanism (29) having a PTO shaft (29) that extends out of said splitter gearbox (30) for remote access thereto, said PTO mechanism (29) being selectively engageable independently of said hydrostatic motor (25) such that said vehicle can be operated with all of the rotational power from said engine (13) being utilized selectively by said PTO mechanism (29) for operation of a remote device or by said hydrostatic motor (25) for traction of said vehicle, said PTO mechanism (29) and said hydrostatic motor (25) both being disengageable to permit substantially all of said rotational power from said engine (13) to be utilized entirely through said auxiliary hydraulic assembly (40).

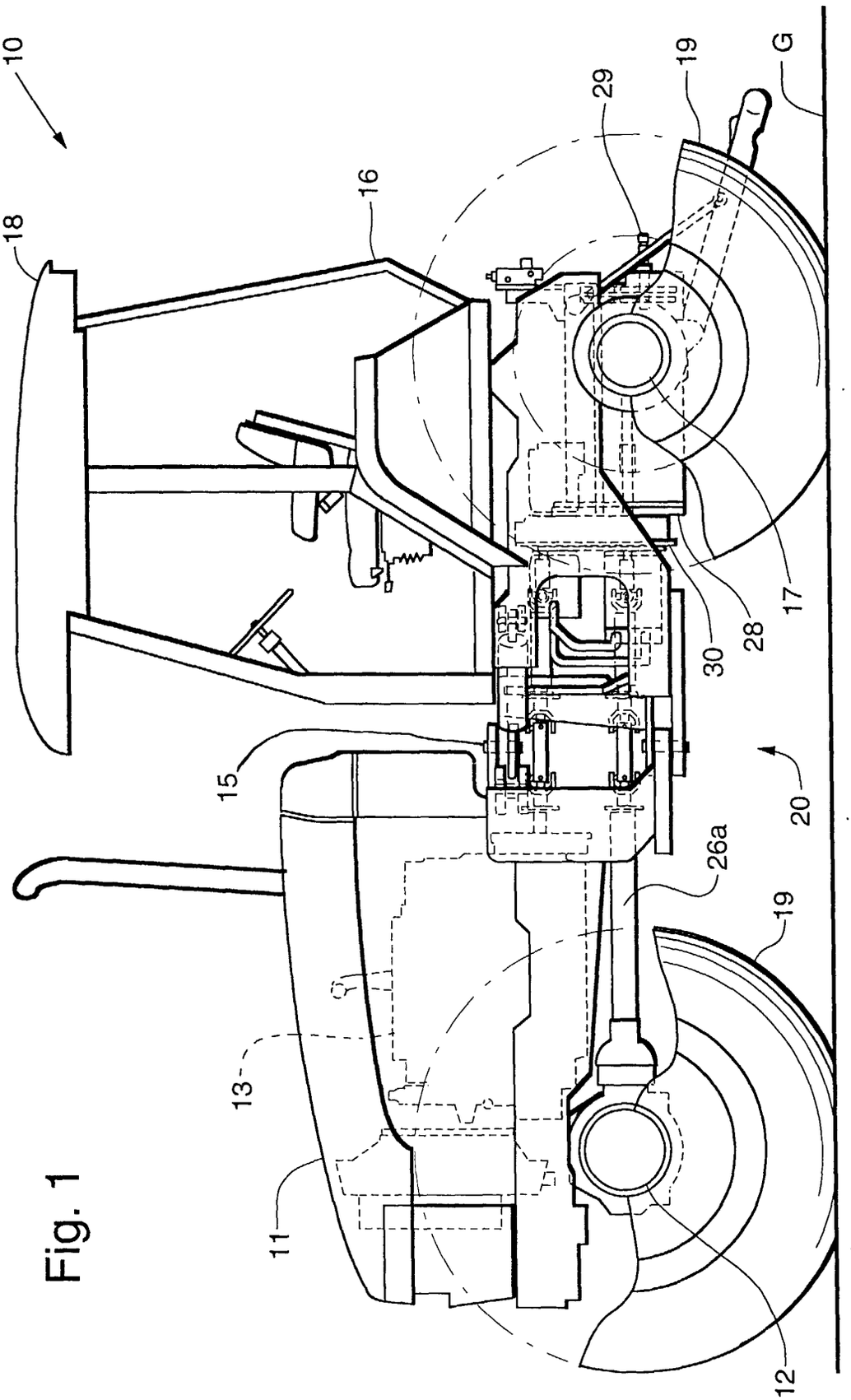


Fig. 1

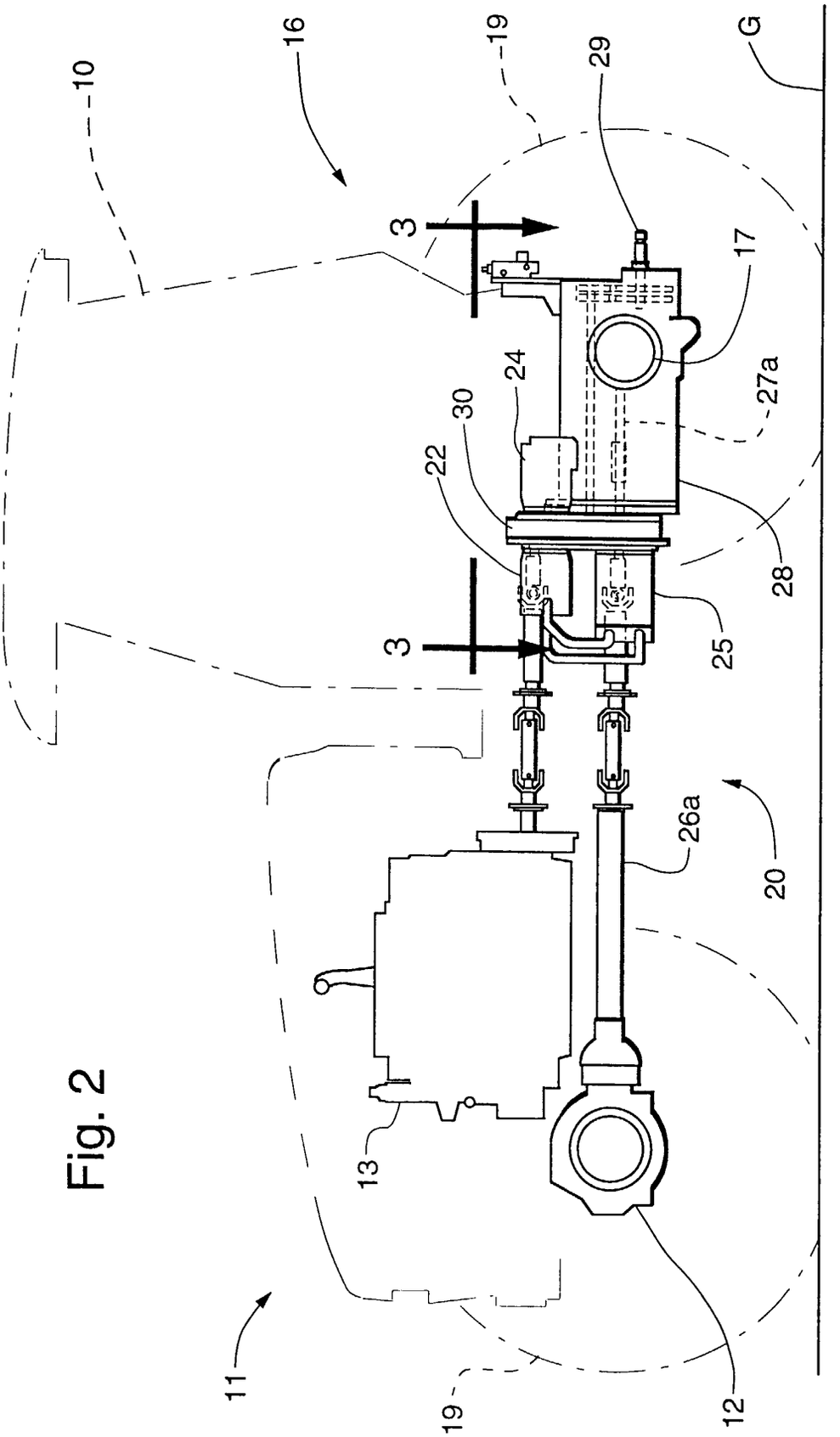
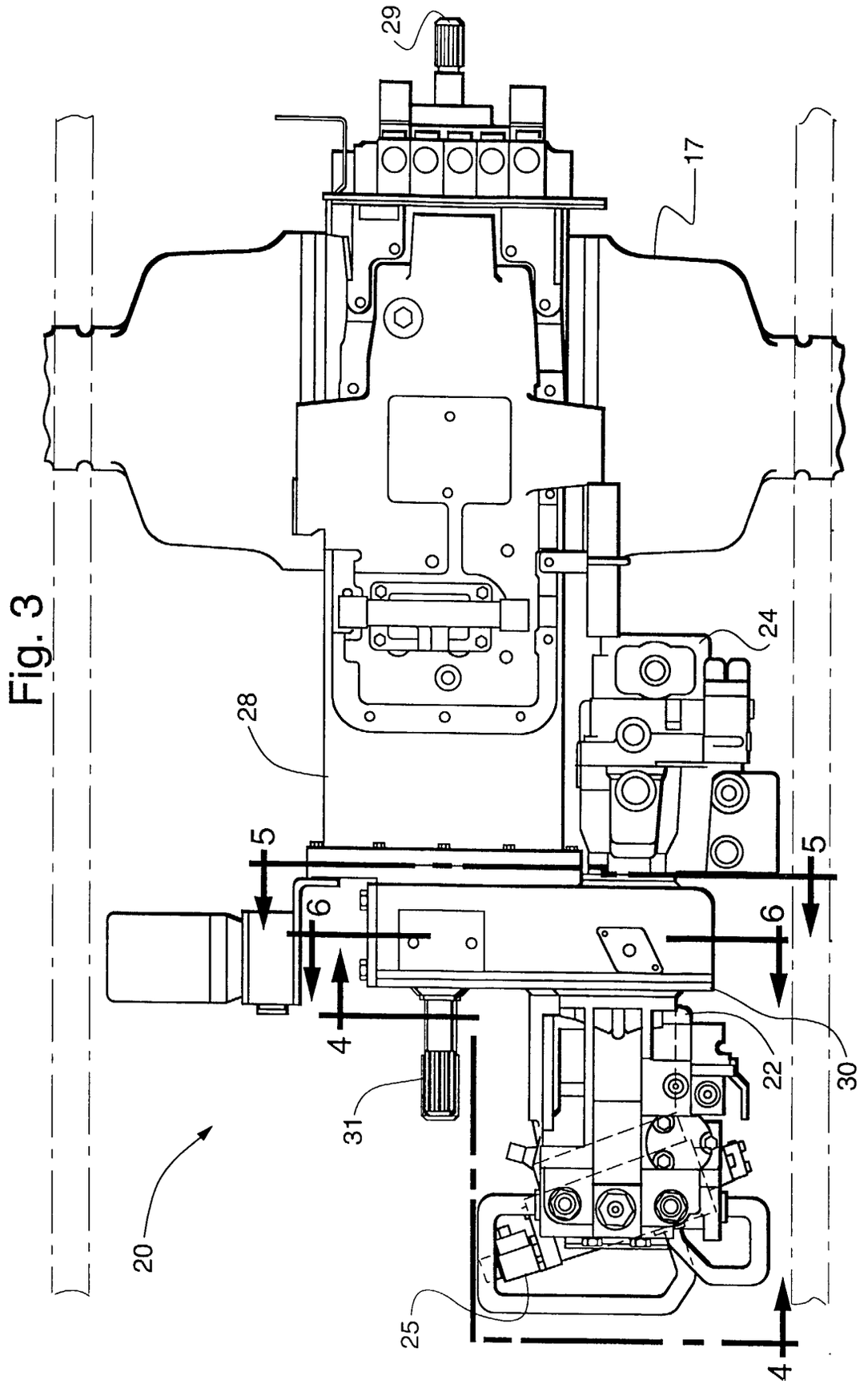


Fig. 2

Fig. 3



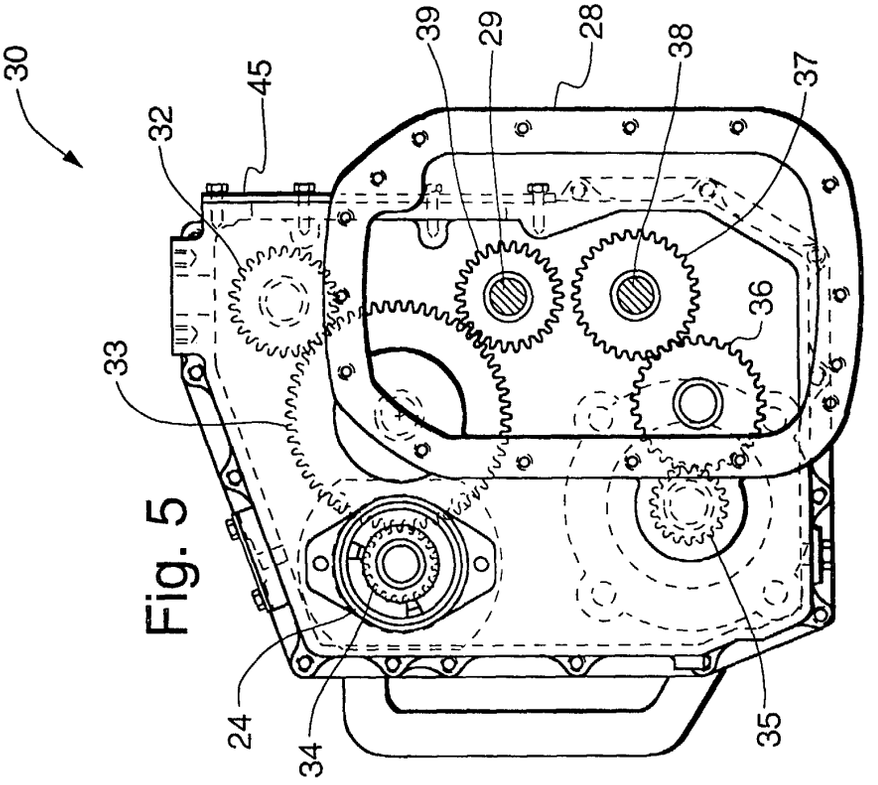

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Fig. 5

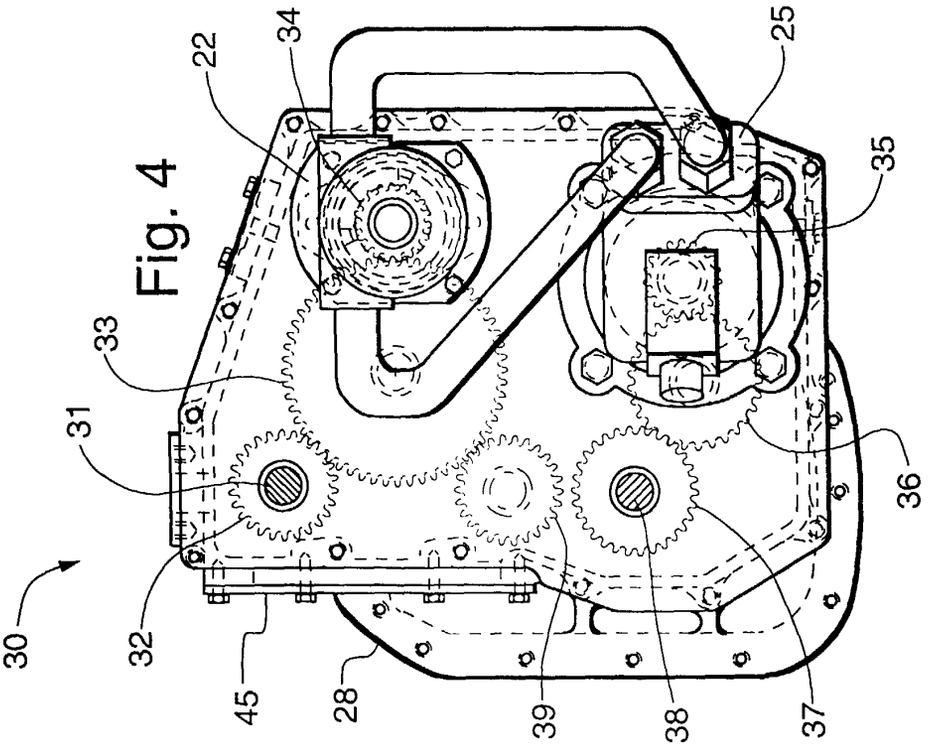
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Fig. 4

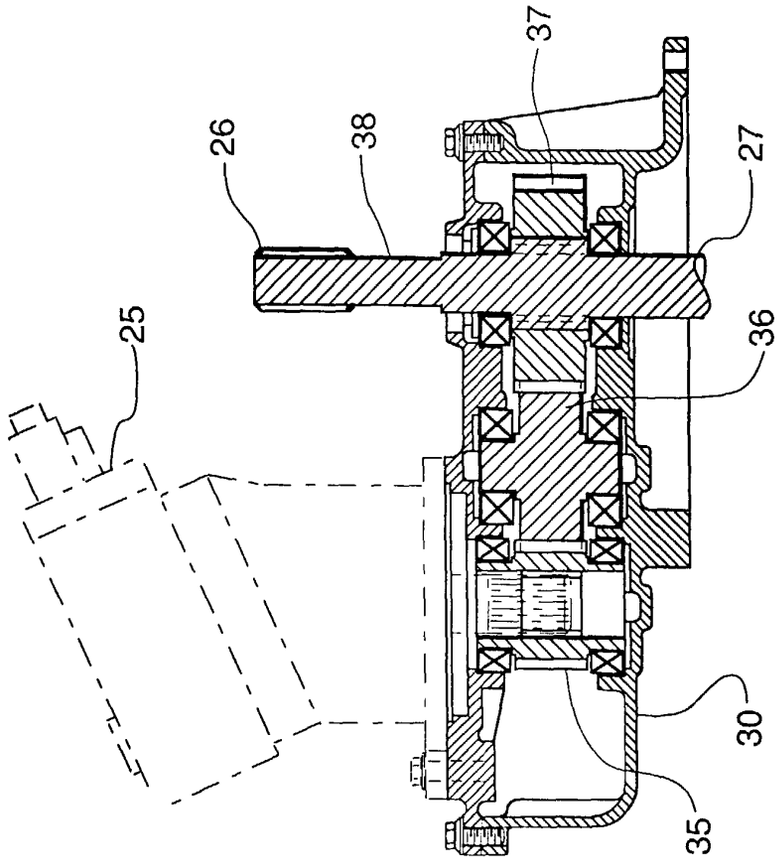

Fig. 7

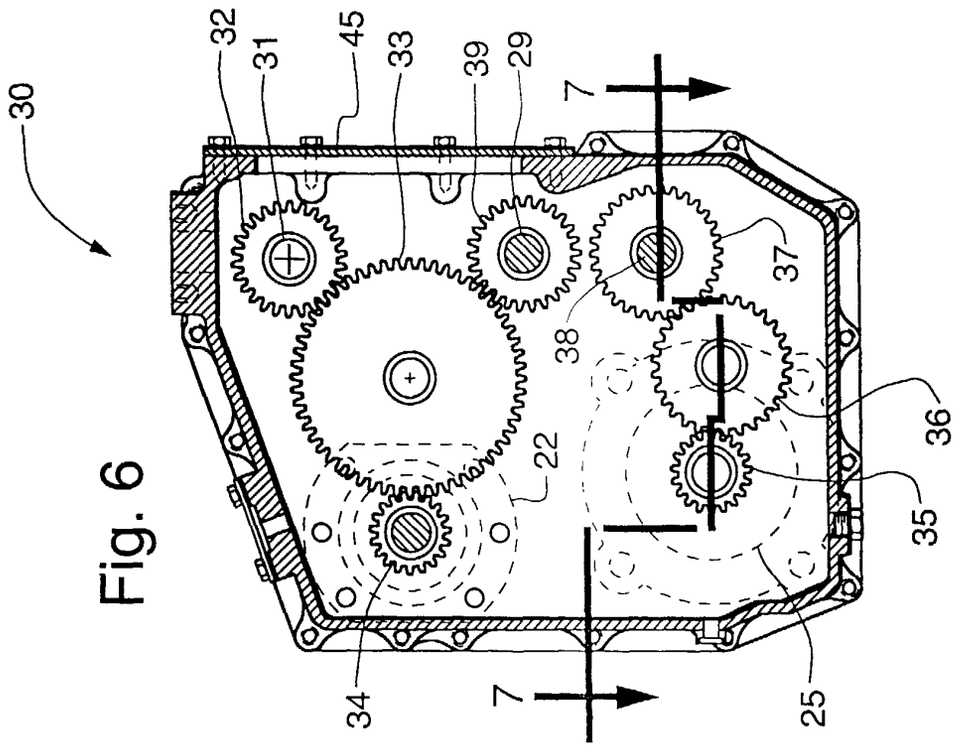

Fig. 6

Fig. 8

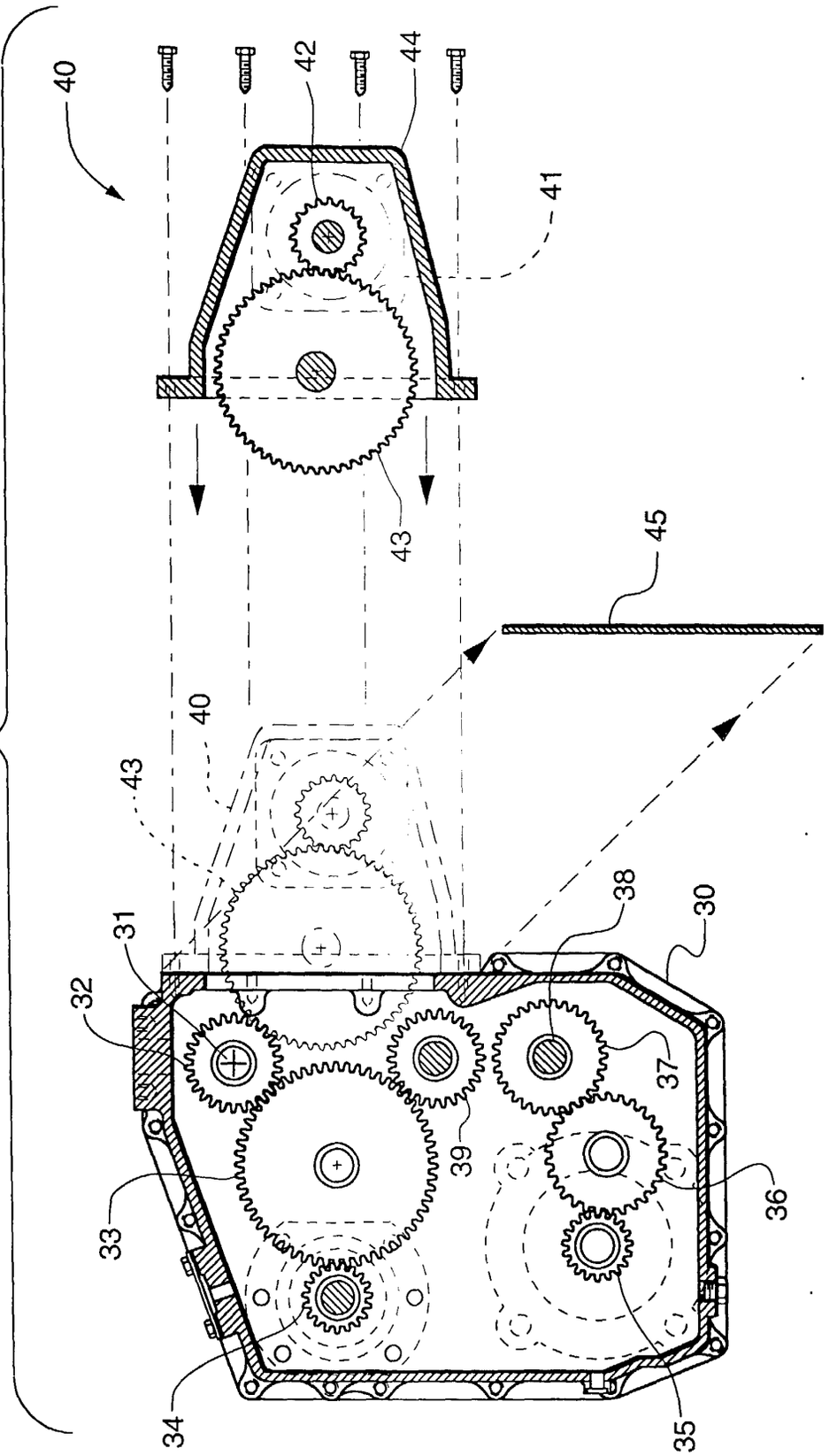

Fig. 9